※ 考生請注意：本試題可使用計算機，並限「考選部核定之國家考試電子計算器」機型

C 卷：材料科學導論(30 題選擇題[1-30], 每題 1 分)、材料力學(15 題選擇題[31-45], 每題 2 分)、工程數學(6 題非選擇題[46-51], 每題 5 分)。滿分 90 分。倒扣至零分為止。

一、 選擇題（請以 2B 鉛筆劃卡作答）

科目名稱： 材料科學導論

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

1. In most vulcanizing, Ⓐcarbon Ⓑhydrogen Ⓒnitrogen Ⓓsulfur compounds are added to the heated elastomer to complete the crosslinking process.

2. A polymer is cooled from liquid melt at a fast cooling rate, then
Ⓐglass Ⓑsemicrystalline solid Ⓒcrystalline solid Ⓓhigh density solid can be formed.

3. For increasing Tg of a polymer, we would achieve by
Ⓐlowering the molecular wt. Ⓑincreasing the linear chain structure
Ⓒpromoting the presence of bulky side groups Ⓓdecreasing the polar side atoms.

4. Acrylonitrile-butadiene-styrene（ABS）with outstanding properties is an important product of Taiwan. It can be used as
Ⓐcar safty protecter in collision Ⓑcamera lens
Ⓒlawn and garden equipment Ⓓflexible bottles.

5. Whiskers have extremely large length to diameter ratios with exceptionally high strengths, they are very thin
Ⓐfilm Ⓑsingle crystal Ⓒpolycrystal Ⓓamorphous solid.

6. The electromotive force（emf） series is genererated by coupling to the standard
Ⓐhydrogen Ⓑplatinum Ⓒsodium Ⓓgold, electrode.

7. From Galvanic series, for protecting iron and steels from corrosion, the anodic materials could be
ⒶCopper ⒷNickel ⒸLead ⒹZinc.

(背面仍有題目,請繼續作答)

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8. A typical magnetic material of Fe_3O_4, the mineral magnetite has a crystal structure of
Ⓐcorundum Ⓑrock salt Ⓒspinel Ⓓinverse spinel.

9. The absorption of a photon of light may occur by the excitation of an electrons from the nearly filled valence band into the conduction band if the phonton energy is
Ⓐequal Ⓑgreater Ⓒless Ⓓnear the band gap of the materials.

10. Use of fiber-optic systems has improved transmission in communications. The fiber material used is Ⓐsilica glass Ⓑalumina Ⓒhigh purity copper Ⓓsuper conductor.

11. Give electron configurations for the Fe^{3+} ions.
Ⓐ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$ Ⓑ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
Ⓒ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ Ⓓ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

12. Covalently bonded materials are Ⓐ equal Ⓑ more Ⓒ less Ⓓ larger dense than metallic or ionically bonded ones because covalent bonds are directional in nature whereas metallic and ionic are not.

13. A Ⓐ 1.588 mm steel sphere Ⓑ diamond cone type Ⓒ 10 mm sphere of steel or tungsten carbide Ⓓ 3.175 mm steel sphere indenter is used in Rockwell C hardness test.

14. The driving force for steady-state diffusion is the
Ⓐ concentration gradient Ⓑ temperature Ⓒ pressure Ⓓ all of the above

15. What is the SI units for engineering stress?
Ⓐ N/m^3 Ⓑ N/cm^2 Ⓒ N/m Ⓓ none of the above.

16. In nitrogen molecules, a Ⓐ single Ⓑ double Ⓒ triple Ⓓ none of the above covalent bonds is formed between the *p* orbitals of two nitrogen atoms.

17. Give electron configurations for the S^{2-} ions.
Ⓐ $1s^2 2s^2 2p^6 3s^2 3p^4$ Ⓑ $1s^2 2s^2 2p^6 3s^2 3p^2$ Ⓒ $1s^2 2s^2 2p^6 3p^6$ Ⓓ $1s^2 2s^2 2p^6 3s^2 3p^6$

18. A Ⓐ crystal system Ⓑ unit cell Ⓒ crystallite Ⓓ crystalline solid is one which has a crystal structure in which atoms or ions are arranged in a pattern that repeats itself in three dimensions.

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19. Copper shows the largest modulus of elasticity values at
Ⓐ [100] Ⓑ [110] Ⓒ [111] Ⓓ [121].

20. The surface energy of a single crystal
Ⓐ increases Ⓑ decreases Ⓒ does not change Ⓓ none of the above with an increase in planar density

21. Which one of the following is the eutectic reaction?
C_E is the eutectic composition. L is the liquid phase.
Ⓐ $L(C_E) \rightarrow \alpha(C_{\alpha E}) + \beta(C_{\beta E})$ Ⓑ $L(C_E) \rightarrow \gamma(C_{\gamma E}) + L(C_E)$
Ⓒ $L(C_E) \rightarrow \alpha(C_{\alpha E})$ Ⓓ $L(C_E) \rightarrow \beta(C_{\beta E}) + L(C_E)$

22. The martensite has which one of the following lattice structure?
Ⓐ FCC Ⓑ BCT Ⓒ HCP Ⓓ BCC

23. When deformation is achieved at a temperature above that at which recrystallization occurs, what the process is called?
Ⓐ plastic working Ⓑ elastic working Ⓒ hot working Ⓓ cold working

24. Which one of the following defects is NOT a point defect?
Ⓐ Vacancy Ⓑ Frenkel defect Ⓒ Schottky defect Ⓓ Grain boundary

25. Which one of the following is Not a polymer rubber?
Ⓐ Styrene Ⓑ Sialon Ⓒ Isoprene Ⓓ Chloroprene

26. Which one of the following material was used to produce plastic toys?
Ⓐ Poly(vinyl chloride) Ⓑ Poly(ethylene terephthalate)
Ⓒ Barium titanate Ⓓ Graphene

27. Which one of the following materials can be used as a shape memory material?
Ⓐ Pearlite Ⓑ Martensite Ⓒ Bainite Ⓓ Austenite

28. The plastic deformation in noncrystalline ceramics is through
Ⓐ bonding energy Ⓑ dislocation Ⓒ viscous flow Ⓓ grain boundary

(背面仍有題目,請繼續作答)

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29. For most of metal materials, creep becomes important only for temperature greater than (Tm: melting temperature)

Ⓐ $0.1\ T_m$ Ⓑ $0.4\ T_m$ Ⓒ $0.9\ T_m$ Ⓓ $1.2\ T_m$

30. Which one of the following is not a mechanical property?

Ⓐ toughness Ⓑ hardness Ⓒ transmittance Ⓓ strength.

科目名稱： 材料力學

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31. The definition of 'homogeneous' means the properties of a material is independent of

Ⓐ density Ⓑ direction Ⓒ velocity Ⓓ position.

32. The general state of stress is described by ***m*** normal components of stress and ***n*** shear components of stress. (***m***, ***n***)=

Ⓐ (3, 3) Ⓑ (3,6) Ⓒ (2, 2) Ⓓ (1,1).

33. Tensile test data can help us to formulate quantitative stress-strain relations. In the original tensile test, what kind of apparatus or instrument should be used?

Ⓐ MTS Ⓑ strain gauge Ⓒ gyroscope Ⓓ dynameter.

34. In tensile test, the true strain ε_x is defines as? (where L_0: original length, L_f: length after test)

Ⓐ $\frac{L_0 + L_f}{2L_0}$ Ⓑ $\frac{L_f - L_0}{L_0}$ Ⓒ $\sqrt{L_f / L_0}$ Ⓓ $\ln(L_f / L_0)$.

35. During the tensile test, the lateral compressive strain is found to be a fixed fraction of the longitudinal extension strain. This fixed fraction is known as the Poisson's ratio, ν. We know the extreme values of Poisson's ration, $m \le \nu \le n$, then, m=

Ⓐ -1 Ⓑ -1/2 Ⓒ 0 Ⓓ 1/2.

36. (Continued) n=

Ⓐ 0 Ⓑ 1/2 Ⓒ 1 Ⓓ 2.

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37. From the feature of a stress-strain curve, the area under the entire stress-strain curve from zero to rupture gives the property known as
Ⓐ modulus of toughness Ⓑ modulus of resilience
Ⓒ modulus of plasticity Ⓓ modulus of rigidity.

38. The stresses in a cylindrical vassel subjected to uniform internal pressure commonly indicated that the stress on a longitudinal plane is
Ⓐ equal Ⓑ twice Ⓒ thrice Ⓓ four times the stress on a transverse plane.

39. Stress concentration is not significant in the case of static loading of a ductile material because the material will
Ⓐ fracture Ⓑ crack Ⓒ yield Ⓓ deform inelastically in the region of high stress.

40. A typical thin-walled spherical pressure vessel used for gas storage , if the weights of the gas and vessel are negligible, symmetry of loading and geometry requires that stresses on sections that pass through the center of the sphere is
Ⓐ zero Ⓑ equal Ⓒ larger Ⓓ smaller

41. A graphical representation is useful because it enables you to visualize the relationships between the normal and shear stresses acting on various inclined planes, that the plane stress can be represented by a plot known as
Ⓐ stress-strain diagram Ⓑ shear force diagram
Ⓒ bending-moment diagram Ⓓ Mohr`s circle.

42. For an isotropic material, there are just
Ⓐ 5 Ⓑ 4 Ⓒ 3 Ⓓ 2 independent elastic constants.

43. A wide variety of structures (e.g. bridges, buildings) are assembled from slender members. If the joints are pinned, the structure is called a truss. The members of a truss carry
Ⓐ transverse loads Ⓑ axial loads Ⓒ no load Ⓓ torsion loads.

44. (Continued) If the joints are rigid, the structure is called a frame. The members of a frame carry
Ⓐ shear force only Ⓑ bending moment only
Ⓒ axial loads only Ⓓ all the above three loads.

45. The definition of 'isotropic' means the properties of a material is independent of
Ⓐ density Ⓑ direction Ⓒ velocity Ⓓ position.

(背面仍有題目,請繼續作答)

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二、非選擇題（請以原子筆在非選擇題答案卷上作答）

科目名稱：工程數學 （每題 5 分）

46. For the given ODE: $y'' + (1+x^2)y = 0$, $y(0) = 2$ and $y'(0) = 6$; Find the recursion formula and list the coefficients of the first five terms of the power series solution.

47. Find the inverse of the transform $\mathcal{I}(f) = \dfrac{7s-22}{s^2-4s+68}e^{-2s}$

48. It is known that $\dfrac{d}{dr}(r\tau_{rz}) = (\dfrac{p_0 - p_L}{L} + \rho g)r$, and $\tau_{rz}(0) = 0$, please calculate for the expression of τ_{rz}.

49. It is known that $\dfrac{1}{r}\dfrac{d}{dr}\left[r\dfrac{dV_z}{dr}\right] = -a$, and $\dfrac{dV_z}{dr}(r_2) = 0$, $V_z(r_1) = 0$, please calculate for the expression of V_z.

50. The enthalpy, H, of a thermodynamic system is defined as $U + PV$, where U, P and V are the internal energy, pressure and volume of the system. The first law tells us that $dU = TdS - PdV$ in a reversible process, where T and S are the temperature and entropy, respectively. Derive the following Maxwell relation:

$(\partial T/\partial P)_S = (\partial V/\partial S)_P$.

51. Mathematical modeling of diffusion in isotropic solids is concerned in this problem. Consider a volume element in the form of rectangular parallelepiped whose sides are parallel to the axes of Cartesian coordinates and are of lengths $2 \times \delta x$, $2 \times \delta y$ and $2 \times \delta z$. Let the center of the element be at P(x, y, z), where the concentration of diffusing substance is C. Let EFGH be the face of the element at $x + \delta x$. Then the rate at which diffusing substance leaves the element through EFGH is $4 \times \delta y \times \delta z \times [J_x + (\partial J_x/\partial x)\delta x]$, where J_x is the rate of transfer of diffusing substance through unit area of the corresponding plane through P. Using the above information and others, derive the equation $\partial C/\partial t = -(\partial J_x/\partial x + \partial J_y/\partial y + \partial J_z/\partial z)$, where $\partial C/\partial t$ is the time derivative of C, and J_y and J_z have the same meaning of J_x but through the planes perpendicular to y-axis and z-axis, respectively.